Columbia Business School
Center on Japanese Economy and Business

CENTER ON JAPANESE ECONOMY AND BUSINESS
日本経済経営研究所

Working Paper Series

May 2016, No. 347

# Heterogeneity in Japanese TFP, Part 2: Regulation, Capital Allocation, and TFP in Japan

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This paper is available online at www.gsb.columbia.edu/cjeb/research

COLUMBIA UNIVERSITY IN THE CITY OF NEW YORK

# Heterogeneity in Japanese TFP, Part II: Regulation, Capital Allocation, and TFP in Japan

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## Abstract

In the first essay of our examination of Japanese total factor productivity, "Why Overcoming Deflation Alone Will Not Solve Japan's Structural Problems," we examined the role of relative deflation of capital goods in an exogenous model of productivity. In this study we gather empirical evidence on sector-specific characteristics of total factor productivity with the latter as an endogenous variable. Using panel regressions of industry-specific total factor productivity (both adjusted and unadjusted for labor and capital utilization) segmented by sector we discover a positive relationship between industry-wide measures of deregulation and total factor productivity in the services sector. However, the coefficient reverses in the manufacturing sector – a drop in already-deregulated manufacturing is consistent with a decline in total factor productivity. Although the direction of causality is indeterminate, an optimal level of regulation across industries in terms of total factor productivity growth appears to lie somewhere between the manufacturing and non-manufacturing sectors. Separately, we find strong evidence that the share of innovative capital scaled by firms' output correlates positively with TFP growth, across most industry sectors. The sum of our findings provide a specific policy argument: to prioritize deregulation in services over manufacturing, moreover that the target of such policy adjustments should be at once to incentivize innovation in not only IT-relevant but also non-IT sectors and to dispose of "dead weight" capital in non-IT related Services industries in particular. We supplement the latter claim with empirical evidence of stagnation in the aggregate quality of capital in non-IT versus IT-related industries and, to a lesser extent, in Services versus Manufacturing.

## 1. Introduction

In the second paper in our "Heterogeneity in Japanese TFP" series, we resume our examination of Japanese total factor productivity in the context of Japan's first disinflationary "lost decade" followed by Japan's descent into deflation.

In our first essay, we examined Total Factor Productivity as an exogenous variable, and provided analytical evidence of some of the structural characteristics of Japan's "lost decades", underpinning our argument that cyclical (this is to say monetary or fiscal) policies alone were insufficient to cure the country's long-term divergence from what is typically considered a "balanced growth path". In our decomposition of growth accounting by industry, we remarked a significant divide in productivity as well as deflators between IT and non-IT industries and used this information to construct a new model better fitted to accommodate this divide. In simulation, we discovered that incorporation of Investment Specific Technology proved useful in explaining

Japanese growth accounting to date, above and beyond a one-sector model. The presence of diverse structural characteristics of productivity is one, if simple, argument against a one-size-fits-all model of structural reform.

We take on board, firstly, evidence that a one-sector model is insufficient in its explanatory power of Japan's twenty-year stagnation in growth and productivity, and secondly, that Investment Specific Technology (as seen in relative capital goods prices) is a sizeable driver of TFP over time.

In our second analysis of TFP, we now examine productivity as the endogenous variable in a multi-sector model. Making especial note of distinct dynamics in capital-producing sectors versus capital-using sectors, we turn to econometric techniques to examine productivity growth across manufacturing versus nonmanufacturing and IT versus non-IT panels. In our search for explanatory variables of productivity, we look firstly to precedents in sector analysis of productivity; we firstly find reason to put greater emphasis on the IT/Non-IT divide to explain divergent moves in capital producing versus capital-using industries. Research precedents also direct the focus of our analysis to regulation and to capital allocation. The main questions we seek to address are:

(a) If deregulation of part or all of a sector is, in a general sense, consistent with a rise in total factor productivity (TFP) across industries and sectors, on a structural basis;
(b) Does capital allocation matter for TFP growth, with regard to:
   i. An industry's investment in intangible capital
   ii. An industry's investment in their economic competencies
   iii. An industry's investment in innovative capital
(c) Is there validity to the claim that regulation inhibits efficient capital allocation and thus holds back productivity (TFP)?

The paper is organized as follows. As a prelude to our own analysis, Section 2 is dedicated to some of the major precedents to our own research, which provide the necessary context for the direction, methodology and assumptions behind our analysis. Section 3 reconstructs growth accounting for IT and non-IT following the guidelines of the Japan Industrial Productivity (JIP) database. Sections 4 and 5 are dedicated to our panel data analysis, in search of explanatory factors of the sectoral productivity divergence. We firstly examine the contribution of regulation and subsidies in explaining movements in Japanese TFP growth in section 4; section 5 is dedicated to the analysis of capital allocation within industries. Section 6 evaluates the combined results of our analysis. Section 7 presents our policy recommendations.

## 2. Precedents in sector analysis of productivity

The first paper in our "Heterogeneity in Japanese TFP" series demonstrated the relevance of Investment Specific Technology (IST) in explaining the slump in total factor productivity that characterized Japan's lost decade.[1] We demonstrated via simulation that adjusting the Hayashi-Prescott Neoclassical

[1] (Fink 2015)

Model[2], by incorporating IST (following methodology put forward by Braun and Shioji[3]), resulted in improved fit versus the realised data. We estimated that IST (proxied by the reciprocal of the price of capital goods in consumption units) was responsible for roughly one-third of TFP growth since the 1970's.

These results make intuitive sense considering the influence of the information technology (IT) revolution, which in most developed countries contributed to a simultaneous drop in the prices of IT inputs and resurgence in output growth from the mid-1990's onward. The concurrence of the IT revolution with Japan's financial crisis of the 1990's creates complexities in identifying the drivers of poor productivity growth, which we strive to untangle.

Our analysis owes significantly to several research precedents into the divergent drivers of Japanese productivity. Generally speaking, research to date indicates that Japan's productivity slump post-1990 may be in some respects exogenous (i.e. the shock of Japan's economic crisis and the slump in labour inputs). But potentially sharing the responsibility for economic stagnation are endogenous factors such as the allocation of resources (within and between industries).

Jorgenson and Motohashi's work on the impact of the IT revolution on productivity in Japan and the US corroborates the significance of Investment-specific technology in lost decade research and also provides a springboard for further analysis. As they point out in their 2005 paper[4], Moore's Law (the rule-of thumb that the density of semiconductor chips doubles every 18-24 months) has generally led to a rapid decline in IT prices, stimulating a "rapidly rising flow of investment into IT equipment and software by IT-using industries" in both Japan and the US.[5]

The exponential capacity increases of semiconductors are not necessarily recent; Gordon Moore originally put forward his observations in the 1960's. Yet it is well documented that the investment flows that gave rise to the IT revolution culminated in the late 1990's, a period that also happened to coincide with the apex of Japan's financial crisis. Even as the former incentivised investment, the latter dampened it. On aggregate, Japanese productivity growth dwindled but did not disappear.

As demonstrated via simulation, the change in IT prices relative to the aggregate price index explains a significant portion of TFP growth since the 1970's[6]. The contribution of IST to productivity growth, of course, was not stable over the entire period. The IT revolution magnified the effects of Investment Specific Technology, and from the late 1990's onward, as the share of the IT sector in GDP growth increased, so did the impact of the drop in IT prices upon overall productivity. Jorgenson and Motohashi demonstrate the growing contribution of IT price declines to TFP growth from the late 1990's onward in both Japan and

[2] (Hayashi and Prescott 2002); The Hayashi and Prescott model was based on the official consumption deflator.
[3] ( Braun and Shioji 2007)
[4] (W. Jorgenson and Motohashi 2005),
[5] Ibid, p. 3
[6] (Fink 2015)

the US[7], reinforcing the measure's appropriateness as a rough proxy for TFP growth over this period.

On one hand, the similarity of developments in the US and Japanese IT sectors is intuitive. As Jorgenson pointed out in an earlier work[8], both Japan and the US are close to the technology frontier in IT. The divergence in aggregate TFP growth rates between the US and Japan owes to lagging technological advances *outside the IT sector* in Japan.

Although industries at the technological frontier contributed an increased share of growth following the IT revolution, two thirds of Japanese output growth after 1995 still came from the non-IT sector (although reduced, as Jorgenson and Motohashi point out, from 89% over 1975-1990 and 85% in 1990-1995).[9] Although the enlarged contribution of IT sectors to TFP growth in Japan was roughly in line with that of the US, that the contribution of labor inputs and productivity growth in the *non-IT sector* were comparatively poor in Japan caused Japanese TFP to under-perform US productivity growth.

The opposing forces of cost-saving technological gains in IT sector output combined with a slump in economic activity accompanying Japan's financial crisis gave rise to a two-speed economy in Japan that persists to this day. We recall from the first paper in our TFP series that the best-performing sectors in terms of TFP growth between 1973 and 2008 belonged primarily to the IT sector, and the worst performing, to the non-IT sector (see Appendix 1: Best and worst performing sectors, sector classification). The massive weight of the non-IT sector in the Japanese market economy coupled with its under-performance in terms of productivity growth argues for further examination of the nature of the divide in sector performance.

Focusing on the contribution of Information Communications Technology (ICT) as well as of resource reallocation to Japanese output growth, Miyagawa, Pyo and Rhee[10] find a suitable comparison in fellow "input-led growth" economy, South Korea. Both Japan and Korea were characterized by high productivity growth in IT sectors and low growth in non-IT sectors from the late 1990's onward; both economies are also characterized by significantly lower productivity in their services sectors than their manufacturing sectors. The decrease in the working age population and fertility rate declines are another commonality between the two, one that however only underscores the necessity of a surge in productivity to achieve a balanced growth path.

Miyagawa et al first examine the ICT investment-to-GDP ratio among developed countries, finding that both Japan and Korea had high ratios in comparison to other developed countries until the late 90's. Japan's ICT to output ratio stagnated after 1995; Korea's meanwhile showed a sharp but momentary drop

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[7] Ibid, p. 18. Jorgenson and Motohashi estimate that about one-thid of Japanese output growth from 1995 to 2003 may be atttributed to IT production in Japan, via contribution of capital services from IT equipment and software, which accopanied the steep rise in IT investment. This rate was a drastic increase from the 10-13% that characterized the period between 1970 and 1995.
[8] (Jorgenson 2003)
[9] Ibid, p. 30
[10] (Fukao, et al. 2012)

at the time of the Asian crisis in 1997, but subsequently picked up to return to similar levels as the highest among developed nations (the US and UK).

A comparison of growth accounting across Japan and Korea *inclusive of capital services* however is more revealing. The contribution of ICT capital services in Japan was comparable to that of Korea and indeed, to that of other developed countries; however (adding further information to the earlier findings of Jorgenson and Motohashi), Miyagawa et al find the most egregious difference in the *contribution of non-IT capital services to overall growth*. When decomposed at the industry level, the researchers find that (non-IT) services industries are the largest offenders.[11] Their examination of resource reallocation effects across sectors also point to firms in the non-ICT intensive non-manufacturing sector as most responsible for negative reallocation effects.[12] Nevertheless, on aggregate, the researchers do not find evidence that capital reallocation effect across sectors was a significant driver of Japan's overall productivity slump.

One important hypothesis arising from this paper was that the low comparative productivity witnessed in services sectors is most likely attributable to "***excessive regulation and a lack of competition in service sectors"*** which in turn "***seem to have impeded introduction of ICT in service industries"***.[13] This hypothesis remains central to our own examination of fragmented Japanese productivity.

In the absence of clear evidence that poor capital reallocation across sectors was responsible for Japan's stagnation, a more recent paper by Miyagawa and Hisa[14] seeks an explanation for the stagnation in Japanese productivity from 1995 onward in the composition of capital within industries. Specifically, the authors posit that the low level of ICT investment that characterized the period 1995 and onward owed specifically to under-investment in intangible capital. Miyagawa and Hisa estimate aggregate intangible investment in Japan, proposing a figure of roughly 42 trillion yen (roughly 9% of GDP). The authors discover that with the IT revolution, the impact of intangible assets upon overall TFP growth increases.[15]

The authors go on to establish estimates of intangible investment at the industry level, further decomposing intangibles into three categories: computerised information, innovative property and economic competencies. Their growth accounting breaks out the capital deepening rate of intangible investment, which otherwise would be included in the Solow Residual (TFP).[16]

[11] Ibid, p. 19. Miyagawa et al single out Distribution Services, finance and business services and personal and social services as under-performing industries in terms of capital services input growth.
[12] Ibid, p. 26. Miyagawa et al cite examples of non-ICT intensive non-manufacturing sectors: real estate, transportation, eating and drinking places.
[13] Ibid, p. 1
[14] (Miyagawa and Hisa 2013)
[15] (Fukao, HIsa and Miyagawa 2012); Authors divided the sample period into two subperiods (1981-1995 and 1996-2008).
[16] Ibid; To further break down these three categories: computerised information consists of custom and packaged software as well as in-house software; innovative property is composed of investment in scienc and engineering R&D, mineral exploitation copyright and licenses costs and other product development, design and R&D. Brand equity, firm-specific human capital and organised structure comprise economic competencies.

Furthermore, the authors use OECD criteria to classify industries into IT and non-IT sectors; industries that provide IT products and services, as well as industries in which the ratio of investment in IT to output is above the median value comprise the IT sector. The remainder comprises the non-IT sector. [17]

As might be expected, IT sector spending on computerised information surpassed non-IT sector spending (by a multiple of nearly 1.7x), and intangible spending overall was greater in the capital-intensive manufacturing sector than in the nonmanufacturing sector. Also, the authors find that the Japanese capital deepening rate of intangible assets is low by international developed country standards, and (as might be expected), skewed toward the IT sector.[18]

Less intuitively, the authors find that industries with a **high ratio of intangible investment to Gross Value Added also allocated the largest proportion of intangibles to innovative property**. Moreover, although more prevalent in the IT sector such industries did not uniquely belong to one category (services vs. Manufacturing; IT vs non-IT).[19] The authors found that "investment in innovative property has a positive and significant impact upon productivity growth."[20], over and above economic competencies and computerised information. In the under-performing services sector in particular however, the authors were unable to find clear evidence of a significant relationship between intangible investment and productivity growth.[21]

In search of a more satisfactory explanation of underperforming services sector productivity, we return to the link between excessive regulation and poor TFP growth, per Miyagawa's earlier hypothesis. Examination of TFP as a dependent variable of regulation has a precedent in the work of Inui[22]. Using data originally compiled for the Cabinet Office's *White Paper on Deregulation* (2000), Inui makes adjustments for the base level of regulation in industries, as well as the importance of individual deregulations. Inui presents analytical evidence behind a stylised fact; that the manufacturing industry is highly deregulated, while the services industry is highly regulated. For his dependent variable, Inui utilised several measures of TFP, including series fully, partially and un- adjusted for capacity utilisation and quality of labor. Controlling for IT capital stock, the size of the industry, knowledge stock (R&D) and a time trend, Inui adopted a fixed effects model for his regression. Apart from industry size (scale), several regression parameters dealing with deregulation demonstrated a high degree of significance with respect to TFP growth. Inui concluded "the TFP growth rate should be expected to rise as deregulation advances".[23] However, Inui did not obtain meaningful results on IT capital and R&D stock.

17 Our work owes greatly to Miyagawa and Hisa's estimation and decomposition of intangible capital investment, as well as categorisation of industries into IT and non-IT sectors, and their subsequent inputs into the JIP database.

[18] Ibid, pp. 414, 422

[19] Ibid; Authors cite Chemicals, machinery, financial intermediation as well as Information and communication industries.

[20] (Fukao, Hisa and Miyagawa, The Measurement of Intangible Investment by Indusry and Its Role in Productivity Improvements in Japan 2012)

[21] (Miyagawa and Hisa 2013); One problematic factor for services is the authors' finding that intangible investment is complementary to IT investment, which tends to be greatest in IT sectors.

[22] (Inui 2006)

[23] (Inui 2006), p. 29

Our own analysis of deregulation very closely follows the precedent set by Inui, though does not necessarily come to the same conclusion across all industries. Inui's conclusion may well hold for the services industry but as he points out, does not make up for the lack of industry-specific evidence on intangible investment as a driver of TFP growth in the services sector (also examined by Miyagawa and Hisa in 2013). We seek to unite the two approaches to gain further information on whether TFP tends generally to improve in response to deregulation and whether more favourable capital allocation shows similar responses in TFP across sectors.

Causality is tough to determine in the best of cases with observational data, and this remains one hurdle in our quest for information on the relationship between regulation, capital allocation and TFP. However, by counterfactual analysis, we hope to shed light on the relationships between deregulation and TFP, capital allocation and TFP and whether sector-specific relationships hold between these two sets of variables and TFP.

In our first analysis (of regulation and subsidies as independent variables), we seek to determine whether industry deregulation was consistent, across sectors with increases in productivity from 1978 to 1998. Given the significance of the deregulation coefficients in Inui's results, we would expect to see similar positive significance for deregulation upon TFP in the services sector. Although we control for R&D investment as well as investment in IT, we expect to see little in terms of contemporaneous significance of these regressors (or lagged by 3 years, in the case of R&D) on TFP in the services sector, per Inui's results.[24]

Our second analysis, which overlaps with the first panel but examines the period dating from 1989 to 2008, examines the relationship between productivity and investment in intangibles, as well as in innovative capital, of which the ratio to output as Miyagawa and Hisa (2013) discovered, were significant for productivity growth. In our latter analysis, we also control for quality of labor and capital; the logic behind these controls is to ensure that our unadjusted TFP remains a relevant measure of analysis of capital composition and productivity (and not a simple proxy for cyclical asset reallocation across sectors).

## 3. Our data: the JIP database and TFP adjustments

In order to construct our analysis of TFP as an endogenous variable, we rely on the comprehensive industry-level data contained within the JIP database. We divide the economy into two parts and examine manufacturing versus non-manufacturing panels. Then, redrawing sector lines, we examine the IT/Non-IT sector divide, maintaining consistent methodology with the first paper in the series[25]. Subsequently we subdivide the manufacturing and services panels into separate IT and Non-IT subsector panels.

The compilation of the JIP database has, in its own right, given rise to a fount of productivity-focused literature. [26] We take note of arguments raised in Fukao et

[24] (Inui 2006)
[25] (Fink 2015), p. 5
[26] We point to the work of Fukao, Inui, Kawai and Miyagawa (2004) and again Fukao et al (2006) for detailed descriptions of the series available within the JIP.

al (2004) for utilizing measures of TFP adjusted for labour quality (demand factors) and capacity utilization (cyclical factors), upon which the measure of TFP changes. Without the adjustment to capital utilization, Fukao et al point out, the Solow residual tends to over-estimate TFP pre-1991 and under-estimate it thereafter. The use of adjusted TFP may be illustrative when examining growth accounting to encompass capital services, as done by Miyagawa and Hisa (2013).

Using Fukao's methodology, we calculate aggregate TFP for IT, Non-IT and Services sectors (see Appendix 2: Growth Accounting (JIP methodology) by Sector). Once again, we find an even greater divide between these two sectors than between manufacturing and services.

As might be expected from a series adjusted for highly cyclical components, the quality-adjusted TFP series are less volatile compared to our unadjusted Solow Residual. As apparent in Figure 1, when compared to the disparity in growth in the Solow residuals for manufacturing and non-manufacturing, there is a smaller gap between growth in manufacturing TFP adjusted for capital and labour quality and its non-manufacturing counterpart. Nonetheless, when we compare the adjusted TFP series for IT versus non-IT sectors, the serial out-performance of productivity in the IT sectors does stand out in the adjusted series much more than the unadjusted series.

In contrast to IT sector TFP growth, which remained positive until the 2005-2009 cohort, Non-IT sector TFP went from under-performing in the booming 1980's to consistently negative in the 1990's and onward. Even in comparison with that of the traditionally under-performing services sector, the (overlapping) non-IT sector's performance is comparatively abysmal over the "lost decades". Moreover, we find that the non-IT sector's modest improvement in the economic upturn of the early 2000's pales in comparison to the Services sector's robust contribution during the same period.

Nonetheless, as research to date[27] has yet to uncover conclusive evidence that poor capital reallocation across sectors was responsible for Japan's productivity slump, we are loath to completely abandon our unadjusted measure. Instead, we examine the unadjusted Solow residual alongside adjusted measures calculated per JIP methodology.

Our central measures of endogenous TFP thus remain our unadjusted Solow residual and TFP measure adjusted for labour and capital quality, using JIP methodology, as follows:

$$TFP_{it} = ln(\Delta Y_{it}) - \frac{CI_{t-1}+CI_t}{2}\ln\left(\frac{I_t}{I_{t-1}}\right) - \frac{L_{t-1}+L_t}{2}\ln\left(\frac{L_t}{L_{t-1}}\right) - \frac{CK_{t-1}+CK_t}{2}\ln\left(\frac{KS_t}{KS_{t-1}}\right)$$

where:

*i = industry*
*CI = cost share of intermediate input*
*I = real intermediate input*
*CL = cost share of labour input*

[27] (Miyagawa and Hisa 2013)

*L = labour input index*
*CK = cost share of capital input*
*KS = capital service input index*

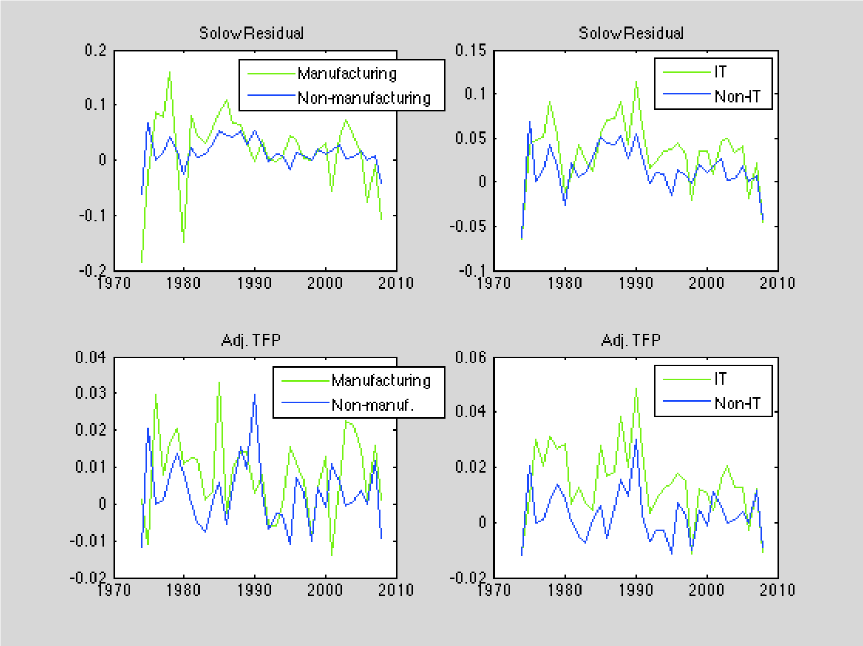


**Figure 1: Growth in Solow Residual (A) vs adjusted TFP**

## 4. Regulation, Subsidies and Productivity

Our first set of regressions centers upon regulation and subsidies in the Services, Manufacturing, IT and Non-IT sectors. We run two separate sets of regressions, one excluding and the other including the indexed time series on Subsidies by industry available from ESRI.

Our endogenous variables include own Solow residuals calculated using our Neoclassical Model of Growth alongside four TFP series made available by ESRI, the subject of study by Nakanishi and Inui (2003) and Inui ("Regulation and Productivity", 2006). We use the Inui services sector model as a template for our own panel data regression of all industries divided by our above-defined sector categories.

We in essence extend the model inspired by Inui's analysis of the services sector to IT, Non-IT and Manufacturing sectors[28] in Japan. Yet our analysis differs from Inui's on several counts. While Inui focused specifically on the influence of regulation on services sector productivity as an end in itself, we are more interested in observing whether the relationship between deregulation and TFP is (a) significant and (b) consistent *across industry sectors* to then reference these conclusions in our subsequent analysis of capital allocation within industry sectors.

[28] IT and Non-IT are mutually exclusive, as are Manufacturing and Services. While output for IT + output for Non-IT comprise the macro-economy, Manufacturing + Services output excludes non-manufacturing, non-services industries.

We remark that the time series we use for regulation differs substantially from the series used in the Inui model; while Inui used eight different measures of regulation we use only two. Data on deregulation come from the Cabinet Office's Deregulation White Paper (2000), indices that gauge the level of regulation by a count of regulations relaxed (with no weighting for importance of regulation, or of pre-existing regulations in the sector). The two indices include one broad (where the regulation applies to all activities in the industry) and the other narrow (where the regulation applies to some activities in the industry). Time series are available from 1978 through 1998.

Historical data include a substantial amount of information on regulatory activity across sectors, including the regulatory period leading up to the IT revolution as well as some of the "Big Bang" reforms in the financial services sector in the late 1990's. Knowing Inui's results, we take as given that the manufacturing sector is less regulated than the non-manufacturing sector.

We employ a Fixed Effects model for all series, followed by a First Difference Fixed Effect Model. The former captures the semi-elasticity of our regressors to TFP growth, and the latter the elasticity. Controlling for industry scale, R&D investment, IT investment and a time trend, we first run the model without the subsidies regressor, then with subsidies. We run a separate regression to include estimated cash levels of subsidies by industry in that these may also exercise a thematically related (but uncorrelated) influence upon productivity as regulation.

Our models are:

Without subsidies:

$$TFPD = a_0 + a_1 REG1 + a_2 REG2 + a_3 RDY + a_4 RDL + a_5 RDY + a_6 ITY + a_7 LK + a_8 SI + a_9 TIME$$

With subsidies:

$$TFPD = a_0 + a_1 REG1 + a_2 REG2 + a_3 RDY + a_4 RDL + a_5 RDY + a_6 ITY + a_7 LK + a_8 SI + a_9 TIME + a_{10} SUB$$

**Endogenous variables:**
A = our own measure of productivity growth (Solow residual)

ESRI productivity measures:
TFPDA: TFP growth rates (baseline case, adjusted for quality of labour only)
TFPDB: TFP growth rates (unadjusted for quality of labour)
TFPDC: TFP growth rates adjusted for capacity utilization, intermediate inputs)
TFPDD: TFP growth rates adjusted for capacity utilization, production indices).

**Exogenous variables (from the JIP database):**

REG1 : Regulation index with some relevant categories subject to regulation
REG2: Regulation index with all relevant categories subject to regulation
RDY: ratio of knowledge stock (R&D) to value added
RDL: ratio of knowledge stock (R&D) to value added, lag of 3 years

ITY: ratio of IT capital stock to value added
LK: labor/capital ratio (input measure)
SI: log value of real value added
SUB (included in 2nd round of regressions): Subsidies
TIME = Time trend

**Period and frequency of panel regressions**: five-year blocs from 1978 through 1998, with average values over time (5-years, ending at observation date) for each variable.

**'T'** for the latter regressions thus equals:
**[1978, 1983, 1988, 1993, 1998]**

**PANELS**: We perform a fixed-effects analysis on two sets of overlapping panels, for each of our five measures of TFP. For the sake of comparison with Inui's work, we start with a panel of Services sector industries (a large subset of non-manufacturing), detailed below. The second is a panel of IT industries (specifically involved either in production of Information Technology hardware, software and services, or any combination thereof). The third and fourth are manufacturing and non-IT panels. We repeat all above steps with differenced data. We then repeat all regressions for our model including subsidies as regressor. Our regression results may be found in Appendix 3: Regression Tables.

**Services sector regression: REG1, RDL and LK are generally significant**
Our first regression is run without subsidies (similar to that in Inui 2006). We generally expected to see for the Fixed-Effects model (in line with the results from the Inui paper) significance of regulation and IT capital stock with respect to the ESRI productivity series (TFPD series). In the capacity utilization-adjusted cases (TFPDC and TFPDD) we expected industry size (scale) to be significant.

As expected, our regressions revealed REG1 (the narrow regulation index) to be significant in all of the TFPD models for the services sector, save TFPDB (the measure unadjusted for labour quality or capacity utilisation) and our Solow residual. The associated coefficients associated with REG1 were, as expected, negative, implying negative association between narrow regulation and services sector TFP. Separately, ITY (IT capital stock scaled by output) was significant only in regressions using the unadjusted A and TFPDB models.

**RDL** (lagged ratio of knowledge stock) and **L/K** (labor/capital ratio) were also significant in all of our regressions, save for our regression using the Solow residual (A). Industry size did not show up as significant in the regression in levels. The significance of **L/K**, while absent from the Inui analysis, shows up strongly in ours, with negative coefficients implying that services sector firms with higher labour/capital ratios were less productive over our observation period. It makes sense that in the regression using our unadjusted Solow residual (**A**), **RDY** is highly significant, with a positive coefficient, but in other adjusted measures, the significance drops, given adjustments to labour, capital quality and other capacity utilization adjustments. Interestingly, **RDL** (3 year lagged R&D stock as a share of output), significant in all of the models, bears a negative coefficient, possibly implying that a high ratio of obsolete technology to output is a drag on TFP.

**Services sector, with subsidies:**
When we add the subsidies **(SUB)** regressor, we find that it is significant for our unadjusted **A** model only, where moreover, it is highly significant. The regressor's significance however disappears with adjustment for labor and capital quality; for all other series, **SUB** is insignificant. However, with the addition of SUB, the significance of Regulation disappears in **TFPDA**, the baseline model adjusted for labour quality. The **TFPDB and TFPDC** regression results are similar to those of the ex-subsidies model. Yet for production side capacity utilization-adjusted **TFPDD**, **RDY** and **RDL** become significant, with positive and negative coefficients respectively. Size (**SI**) also gains significance, with a positive coefficient, while the regulation effect disappears. The latter implies that this smoother, cyclically adjusted series remains highly sensitive to moves in intangible capital stock, which contrasts with our unadjusted **A** (inclusive of labor and capital quality adjustments), which is significantly and negatively influenced by subsidies.

It is possible that subsidies are influential chiefly in the allocation of labor and capital across industries, though not for technological advancement as a whole; regulation is much more consistently influential than subsidies upon total factor productivity in the services sector (both inclusive and exclusive to quality of capital and labor adjustments).

When we examine the Fixed Effects model with first differences, we find that **dREG1** was highly significant in all of our models, excluding **A** (**Solow residual**). This was the case both with and without the **SUB** series. TFP adjusted for labor and/or capital appears highly elastic to changes in regulation (narrowly-based). **dITY** becomes highly significant for all series in our first differences model (including Solow residual **A**) without subsidies, although the coefficient fades in significance when we add the **dSUB** regressor to the first differences model. We recall that in the undifferenced regression series (semi-elasticities), **ITY** was only significant for **A**, **TFPDA** and **TFPDB**. The results would indicate that in the absence of subsidies, TFP in the services sector (and not only cross-industry allocations of labor and capital) is elastic to changes in IT investment.

**Other sectors: IT, Non-IT and manufacturing**
We repeat the panel analysis conducted for the services sectors for IT, Non-IT and manufacturing sectors to gauge differences in drivers of TFP including regulation, subsidies, IT capital stock, R&D investment and labour/capital ratios. While manufacturing and services are exclusive (as are IT and non-IT), the two sets overlap.

**IT sector**: We find very little of significance with regard to the IT sector in this regression. Although for **A** (the unadjusted Solow Residual), REG1, REG2, ITY and LK are all mildly significant; none of the regressors is significant for any of our adjusted **TFPD** series. This in itself could indicate that regulation, controlled for industry size, IT capital stock, scale, labor/capital ratios, etc may be more influential on capital service or labor quality rather than technological component of TFP. At the very least, it appears as though the *same factors do not determine TFP in the IT and Services sectors, particularly after adjustments for capacity utilisation*, particularly when in regard to regulation.

When we examine the Fixed Effects first differences regressions, the picture does change somewhat. TFP growth is highly elastic to **dITY** (with a negative coefficient) for labour quality-unadjusted **TFPDB** as well as for **TFPDC** (input capacity utilization adjusted) and **dLK** becomes significant (with a positive coefficient) for all models. This result could simply mean that the change in IT capital per unit output is emulating the build-up of investment in overall capital per unit output, and as output drops, so does TFP growth. In short, the result says more about the capital-to-output ratio than it does the beneficial aspects of IT investment. Finally, we find that **dREG2** becomes significant – and the coefficient associated with a positive change in regulation is negative for TFP.

When we introduce **subsidies (SUB)**, the model reveals the significance of **REG1** only, although the **SUB** term is only significant (with a negative coefficient) for the unadjusted Solow residual, **A** (as in the Services panel). The regressors **dREG2** and **dLK** become important in first differences in our model with SUB (as in the model without Subsidies).

**Manufacturing and non-IT sectors**: We find that in the **Manufacturing** sector, the most consistent factor across TFP measures and across both models (with and without subsidies) is the **significance of regulation**. In our model *without* subsidies, **dREG1** ('narrow' regulation of some relevant categories) was significant in our first difference Fixed Effects model, while with subsidies **dREG2** ('broad' regulation of all relevant categories) was significant. The result may have to do with overlap between targeted subsidies and narrowly focused regulations. But the most interesting result within this sector was the *fact that, **unlike in the services sector, the regulation coefficients were positive***, implying that in the much less regulated manufacturing sector the change in variance of TFP measures explained by regulation was positive. This is interesting, particularly remembering from our Services sector result that TFP is negatively associated with an increase in regulation.

One possible interpretation of this result provides food for thought (and potentially, for further analysis): that an *optimal level of regulation might lie somewhere in between the highly-regulated Services sector and the relatively deregulated Manufacturing sector*, where imposition of new regulations appears to be associated with positive changes in productivity. In order to come to this conclusion however, greater evidence of causality must be ascertained first (which in our panel regression it is not).

For the **Non-IT sector**, we find in our fixed effects models that **subsidies** are not significant in any of our TFP models, either in levels or in first differences; the message here appears to be to *think twice before considering a subsidy programme designed to enhance TFP in the non-IT sectors*. This is important, given Non-IT is more highly subsidized than IT sectors (and also a larger portion of government transfers). Meanwhile, for both models (with and without subsidies), **both dREG1 and dREG2** were significant across most measures of TFP. The coefficient for **dREG1** is negative and strongly significant, while **dREG2** is positive, and less significant. This tendency has interesting implications for policy; it tells us that there is a *strong negative association between TFP and partial regulation in the Non-IT sector, but a mild positive association between industry wide regulation and TFP*. This could be for a variety of reasons; for instance, there may be a macroprudential element to industry-wide regulations, contrasting with the anti-competitive nature of partial regulations specific to parts of the industry. The result merits further case-by-case analysis to further examines the response of non-IT industries to different types of regulation. In all differenced models, non-IT sector productivity was significantly elastic to **dLK** (changes in the labor/capital ratio) and **dSI** (changes in scale).

Further areas for analysis (that we have not considered in our study) might include consideration of market concentration ratios in the discussion of subsidies (as monopoly industries tend to be more protected). Beyond this, more detailed quantitative analysis of regulatory impact might be conducted at the level of the firm.

**Cross-segment panels dREG effect is concentrated in Non-IT Services**
Next, we take advantage of the overlapping structure of our panels; we segment our IT and Non-IT panels into Services and Manufacturing subsectors. IT-Services contains 11 industries, while non-IT Services (the weakest link in terms of TFP) contains 16. We perform another set of first-differenced fixed-effect panel regressions.

We find coefficients associated with Regulation (either REG1 or REG2) broadly (and negatively) significant only in the **Non IT- Services sector** mostly at the 5% and 10% confidence levels across our **labour and capacity adjusted TFP** series, TFPDC and TFPDD. The result suggests, specifically for the non-IT services sector, greater than cyclical relevance, independent of the effects of reallocation of labor or capital across industries. The results also suggest that this subsector, lagging far behind the technology frontier and the "weakest link" in terms of productivity growth, might garner benefits from deregulation. Whether this sector suffers in productivity because of excessive regulation (hence the negative coefficient), or whether instead (as the direction of causality is indeterminate) regulations are introduced to protect these low-productivity sectors for other reasons, we see very distinctly the juxtaposition of TFP gains (losses) alongside simultaneous deregulation (regulation).

For **Manufacturing**, where before we found that regulatory (**dREG1 and dREG2**) coefficients showed varying degrees of significance in our first differences model, when we split the panel up into IT and non-IT manufacturing, regulatory coefficients tended only to gain significance when we controlled for subsidies (**dSUB**). Recalling our results (above) on the significance and positive effects of broad regulations in the manufacturing sector on TFP in the presence of subsidies, the interplay between subsidies and regulation in the already deregulated (and out-performing) manufacturing sector may merit further examination.

Separately, we find positive significance for **dRDY** across **Services** sectors (both IT and non-IT). Also of significance for both categories of Services is **dITY**, though its negative coefficient suggests that the ratio of IT stock bears greater adherence to the theoretical relationship between TFP and the overall capital/output ratio (TFP declines with output) than does its intangible counterpart, R&D. Nonetheless, we note that the negative significance of **dITY** drops out when we add the dSUB regressor, even though the latter regressor does not gain in significance.

The combination of these results becomes consistent with our second set of regression results, pertaining to innovative versus intangible property stock. Although intangible capital tends to adhere the typically negative relationship between TFP and overall capital-to-output ratios, its subset (innovative capital, inclusive of R&D stock) bucks this trend. It is possible, given the opposite signs of R&D and overall capital stock (both as a ratio of output) when in regard to TFP, that simultaneously increasing innovative capital and cutting dead-weight capital are necessary in order to achieve improvements in TFP growth.

## 5. Intangible Investment, Capital allocation and Productivity

We next focus on the theme of capital allocation, and specifically examine intangible investment and its components. We continue to divide our panels into manufacturing/nonmanufacturing as well as into IT/non IT segments. As mentioned in Section 3, our second set of panel regressions owes significantly to work done by from Fukao, Miyagawa and Hisa (2012) on contributions of intangible investment and its components.

By incorporating findings from Fukao, Miyagawa and Hisa (2012) and Miyagawa and Hisa (2013), we also avoid the dummy variable trap in our regression by including explanatory variables in our model for overall Intangibles as well as components Economic Competencies and Innovative Capital, yet excluding computerized information, which according to these studies failed in its explanatory power of moves in TFP in any sector.

As in our first set of regressions, we control for labor/capital ratios and industry size, as well as a time trend. Additionally, we also control for quality of labor and capital (calculated in accordance with JIP methodology) in our regressions. Our JIP-compiled measures of TFP exclude these factors. We would however expect our Solow residual (though compiled independently of JIP methodology), to be influenced by quality of labor and capital where the adjusted JIP measure is not (and thus expect to see less than strict exogeneity in this measure).

Our model specifications are:

**Regression:**

$$TFP = a_0 + a_1QL + a_2QK + a_3INTAY + a_4ECOC + a_5INNY + a_6LK + a_7SI + a_8TIME$$

**Endogenous variables:**

A = our own measure of productivity growth (Solow residual), by industry
TFPD = JIP labour and capital quality adjusted measure of TFP growth

**Exogenous variables (from the JIP database):**

QL: Quality of labour index
QK: Quality of capital index
INTAY: Stock of intangibles (ratio to output)
ECOC: Investment stock of 'economic competencies' (ratio to output)
INNY: Stock of innovative property (ratio to output)
LK: capital/labour ratio (input measure)
SI: log value of real value added
TIME = Time trend

**Period and frequency of panel regressions:** five-year blocs from 1989 through 2008, with average values over time (5-year averages, ending at observation date) for each variable.

**'T'** for the latter regressions thus equals:
**[1989, 1994, 1999, 2004, 2008]**

**PANELS**: We perform a fixed-effects analysis of TFP, segmenting industries into IT and Non-IT, Manufacturing and Services sectors, first in levels (to retrieve semi-elasticities), then differences (elasticities).

**IT:** For our Solow residual (**A**), the stock of intangibles relative to output (**INTAY**), and specifically of **innovative property** proved significant (consistently with results seen in Miyagawa and Hisa (2013)), while for adjusted **TFPD**, only investment stock of Economic Competencies (ECOC) mattered. Taking first differences in regressors, the results for the two measures (A and TFPD) look more alike. **dINTAY** and **dINNY** were significant for both of the models, though more so for **A**, the unadjusted measure. The signs of the coefficients told a more interesting story – while for intangibles as a whole, their share to GDP was correlated negatively with TFP growth (which per theory as well as empirical analysis[29] is positively correlated to output), the share of innovation to output (**dINNY**) was positively correlated with TFP, indicating that the moves of this subset of capital might be more important to productivity than capital investment as a whole, or even intangible capital investment. The result may be one indication that quality of intangibles matters for TFP overall, not limited to productivity exclusive of Quality of Labour or Capital. Pertinent to this result, we found no significance in either in levels or differences for indices of Quality of Capital *or* for Quality of Labour) upon either TFPD in the IT sector (as expected) or A. For growth in the unadjusted Solow Residual (**A**), the scale of industry **dSI** was also strongly significant, with a positive coefficient (consistent with increasing returns to scale).

**Non-IT:** Our Fixed Effects panel yields a very similar picture for Non-IT as for IT in terms of levels – we have strong significance (with negative coefficient) for **INTAY** in our Solow residual (A) model, with similarly strong significance (but

[29] (Fink 2015), Appendix 1

positive sign) for the **INNY** coefficient. For the adjusted TFP measure, **ECOC** once again becomes significant, with negative coefficient. Given IT and non-IT together comprise the macroeconomy, we might finally make a generalized hypothesis across sectors; that *while the build-up of intangible stocks relative to output appears a side effect of slowing growth (and thus TFP), innovation matters for total factor productivity above and beyond moves in output growth, for both IT and Non-IT sectors.* It is possible furthermore that the opposite coefficients for innovative capital versus other types of intangible capital are also indicative of the benefits of speedily cutting "dead weight" capital unrelated to innovation.

Finally, we notice one key difference – that the ratio of labour to capital **LK** (in levels) is significant in our adjusted TFP regression for non-IT, while it is not for the same adjusted measure in the IT sector. We find **dSI** significant for both of our differenced Fixed Effects regressions (**A and TFP**), indicating that scale effects might be more significant in Non-IT than in IT. This makes intuitive sense, since Non-IT industries includes many large-scale capital-intensive industries such as Mining, Air Transportation and Iron and Steel production, as well as Other Services for Individuals, which includes many small-scale, low-output industries further away from the technology frontier.

Noting once again that both IT and Non-IT cross the boundaries of manufacturing and services, we re-ran our second set of panel regressions across Manufacturing and Services sectors. These however offered little significant information; the only significant outcome was that the Manufacturing model did yield larger scale effects (significance of SI) than they did for Services, where SI is not so significant. That scale is more important in manufacturing than in services is no great revelation.

**Splitting the Intangibles panel:** When we split our panels into IT-Manufacturing, IT-Services, Non-IT Manufacturing and Non-IT Services, we find results roughly consistent with our individual sector analyses. By and large, we find **dINTAY** and **dINNY** as most significant across several sectors. That said, the pattern of significance does change depending on sector and measure of productivity. For **IT – Services**, both of these coefficients were significant, positively for **dINNY** and negatively for **dINTAY**, which is consistent with results obtained in our first set of regressions. First differences in intangible stocks to output (dINNY) follow the theoretical (inverse) relationship between TFP and capital-to-output while changes in innovative capital/output correlates positively. This is also the case for **A** (Solow Residual) in **Non-IT Services** (the weakest link) though the significance of **dINNY** fades for measures TFPD (adjusted for capital and labor quality). Curiously, we find that for **IT-manufacturing**, **dINNY** drops out of significance. Meanwhile, we find that **QK** is negatively significant for the non-cyclically adjusted (A) measure of TFP in the non-IT manufacturing sector but all factors fall out of significance for TFPD.

Examining first differences for **Non-IT** manufacturing TFP, **dQK** (quality of capital) suddenly becomes significant – and negatively significant in the TFPD (adjusted) series, which simply shows that this partial complement of narrowly defined TFP diverges in performance from the "technology" aspect of TFP, as might be expected in a detrended cyclically adjusted process.

One question to ask is whether the results suggest that the deflationary impact of improvements in quality of capital (influenced in turn by investment-specific technology) are somehow related to structural underperformance in the non-IT sector, where for the IT manufacturing sector the effects of capital quality adjustments adheres more to expectations, i.e. remain cyclical.

This could be an area for future detailed analysis, including perhaps at the firm level.

## 6. Evaluation of results: deregulation helps only up to a point

We find significant divergent relationships between regulation and several measures of productivity growth in the Manufacturing versus Services sector. Productivity tends to rise as regulations are relaxed or eliminated in the Services sector, whereas in the deregulated Manufacturing sector, further deregulation is consistent with a simultaneous drop in total factor productivity. We posit that an optimal level of regulation could lie somewhere between that of the highly regulated Services and deregulated Manufacturing sectors.

Although the Non-IT sector shows some sympathy with the Services sector in that narrow regulation is a more significant explanatory factor of TFP, regulation loses significance in the IT sector (except in the presence of subsidies).

Separately, we find evidence in our first set of panel regressions that while the ratio of IT capital to output tends to surge alongside drops in TFP and output, the ratio of R&D capital (a subset of innovative capital) shares a positive relationship with TFP growth in the Services sector (across both IT and non-IT services), a result that is corroborated in our second set of panel regressions for the IT-Services subsector.

In our second set of panel regressions, we find that ratio of innovative capital to output has a significant contemporaneous relationship to TFP in both IT and Non-IT sectors. This is a contrary trend to the ratio of (larger) components of the aggregate industry balance sheet such as intangibles (of which innovative capital is a subset) and investment stock in "economic competencies". A growth slump, consistent with a drop in productivity across sectors, is accompanied by a build-up in capital to output ratios. Intangibles and economic competencies follow this tendency, while innovative capital does not. When run for Manufacturing vs Services segments, the results are much less defined than when run for IT and Non-IT panels.

However, when segmented into four subsector panels, there is some evidence that innovative capital may influence TFP via capital services in the Non-IT Services subsector. As might be seen in Figure 2, the stunted growth in quality of capital characteristic of the **Non-IT** sector stands out above and beyond the split seen in Manufacturing vs. Services. Stagnation of capital services growth is indicative of negative contributions from capital reallocation across industry to overall TFP growth.

**Conclusion:** While it is possible that over-regulation and dampened competition in the Services sector in particular leads to poor capital allocation, counterfactual evidence from the manufacturing sector suggests that the benefits of incremental deregulation may not be generalised across all sectors. The positive coefficient associated with regulation as an explanatory variable of total factor productivity in the manufacturing sector provides evidence against the hypothesis that marginal deregulation across all industries and sectors leads conclusively to higher productivity growth. Conversely, coefficients for the ratio of innovative capital to output are uniformly positive across sectors, which implies that capital allocation does matter in both IT and non-IT sectors, to productivity growth.

We find evidence of heterogeneity in Japanese TFP in both our theoretical and empirical exercises. Recognition of the impact of investment-specific technology (IST) as a contributor to Japanese productivity growth not only provides more accurate simulations of Japanese growth accounting at the macro-economic level, but it also opens a new line of inquiry; what information does relative price developments hold for the composition of productivity, and thus for developments in aggregate productivity growth?

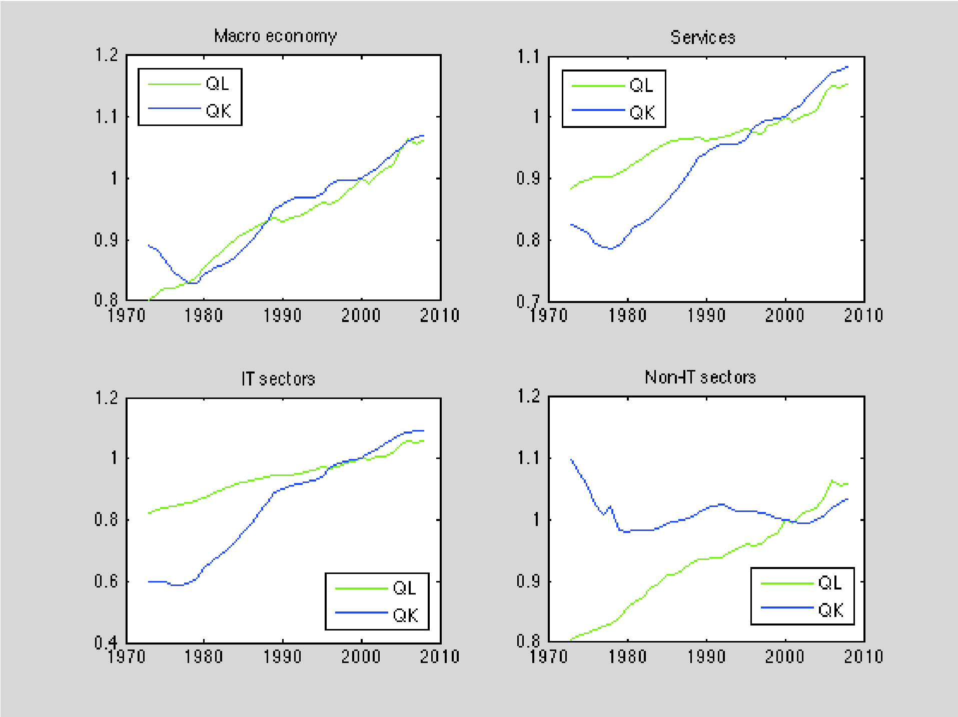


**Figure 2: Quality of Labour, Capital by Sector**

## 7. Policy recommendations

We find that the *same factors do not determine TFP growth in the Manufacturing and Services sectors* and our policy recommendations keep this heterogeneity in mind at all times.

As we find *inverse coefficients attached to regulation* in highly regulated versus relatively deregulated industry groups. The highly regulated Services sector, particularly the Non-IT Services sector, appears to be one area where successful capital allocation appears to have stagnated. Given that productivity in this sector appears to be receptive to deregulation; also given capital allocation is also poor in the sector (with a low allocation to innovative capital), further thought should be given to ways in which market liberalizing reforms might help boost productivity in the Non-IT Services sector in particular.

Our results reinforce those of Miyagawa and Hisa (2013), in underscoring the importance of innovative capital. Increasing intangible capital alone has proven no indicator of rising TFP in the services sector. We second their recommendation that policies focused on promoting growth (via intangible investment alone) in the services sector (as in the early 2000's) might prove misplaced. The caveat raised in the same essay[30] - that intangible investment is complementary to IT investment – still remains a hurdle for Services sectors.

Further analysis on allocations to innovative capital as a ratio of the overall capital base might be advisable; we hypothesise that alongside under-investment in innovative capital, the failure to reallocate capital away from non-innovative "dead weight" capital might dull productivity.

When in regard to development of policy-specific analytical tools, Miyagawa and Hisa recommended further quantitative analysis including estimation of a production function incorporating intangible assets, we would add to this further estimation and econometric analysis of (a) innovative capital scaled by capital rather than output and (b) a measure of disposal of "deadweight" capital in the Non-IT Services sector in particular.

When implementing new regulations (or deregulations), higher-frequency analysis may be merited. Gathering of higher-frequency and more up-to-date measures of industry regulation and deregulation, as well as on compliance costs would be recommendable. Compilation of a Computable General Equilibrium model to gauge the impact of deregulation in various services industries might then prove useful as a policy tool.

Complementary qualitative studies on deregulation (such as case studies) in highly regulated industries may be merited. Econometric analysis at industry level also has its limitations; structural phenomena such as the history of intertwined corporate and institutional relationships lingering from the *zaibatsu* and then *keiretsu* eras potentially embedded in the error terms of our regressions, are not easily extractable as data.

Separately and of broader applicability than to Japanese policy alone, further examination of shocks to Investment Specific Technology (IST) in a dynamic framework upon both prices and productivity is most likely merited. One of the primary motivators of price declines in the IT sector (exponential growth in semiconductor density) has subsided; in other words "Moore's Law" appears to be breaking down[31]. If so, the IT sector's share of productivity growth may once again shrink (just as it expanded in the years following the IT revolution). The IT sector as a key source of productivity-enhancing relative price declines may not be as dependable in the future as it has been since the 1970's. We should not assume that growth in IST is a constant, either in absolute terms or as a contributor to overall TFP.

Examination of the impact of a potential shock to IST not only on overall productivity but also on prices using a dynamic stochastic model to gauge the

[30] (Miyagawa and Hisa 2013), p. 423
[31] http://blogs.wsj.com/digits/2015/07/16/intel-rechisels-the-tablet-on-moores-law/

cyclical impact of such a shock and its implications for asset prices and fiscal and monetary policies may prove to be a fruitful policymaking exercise.

## Acknowledgements

Thanks to Professors Juan Carlos Conesa and Etsuro Shioji for their input and to Samer Barakat for his assistance.

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## Appendix 1: Best and worst performing sectors, sector classification[32]

| Top 10 by TFP growth 1973-2008 | % | Manuf. | IT | Non-IT | Services |
|---|---|---|---|---|---|
| Electronic data processing machines, digital an analog computer equipment and accessories | 4.98 | x | x | | |
| Telegraph and telephone | 4.52 | | x | | x |
| Semiconductor devices and integrated circuits | 3.80 | x | x | | |
| Communication equipment | 3.23 | x | x | | |
| Household electric appliances | 3.06 | x | x | | |
| Electronic parts | 2.78 | x | x | | |
| Pharmaceutical products | 2.74 | x | x | | |
| Office and service industry machines | 2.74 | x | x | | |
| Electronic equipment and electric measuring instruments | 2.02 | x | x | | |
| Motor vehicles | 1.72 | x | | x | |

Top ten industries in terms of TFP growth 1973-2008, as member of aggregate

When we examine the worst-performing industries in terms of TFP growth between 1973 and 2008, we observe that the manufacturing/non-manufacturing split is not as clear as among the best-performing:

| Bottom 10 by TFP growth 1973-2008 | % | Manuf. | IT | Non-IT | Services |
|---|---|---|---|---|---|
| Petroleum products | (9.66) | x | | x | |
| Basic organic chemicals | (8.08) | x | | x | |
| Prepared animal foods and organic fertilizers | (6.83) | x | | x | |
| Coal products | (6.79) | x | | x | |
| Real estate | (3.53) | | | x | x |
| Organic chemicals | (3.40) | x | | x | |
| Electricity | (3.33) | | | x | x |
| Chemical fertilizers | (3.25) | x | x | | |
| Waste disposal | (2.98) | | | x | x |
| Rice, wheat production | (2.78) | | | x | |

Bottom ten industries in terms of TFP growth 1973-2008 as member of

32 Reproduced from (Fink 2015), p 9

## Appendix 2: Growth Accounting (JIP methodology) by Sector

Manufacturing sectors (JIP)

| | 1970-75 | 1975-80 | 1980-85 | 1985-90 | 1990-95 | 1995-2000 | 2000-05 | 2005-09 |
|---|---|---|---|---|---|---|---|---|
| Real GDP Growth | 2.70% | 7.53% | 7.08% | 5.11% | 0.49% | 0.91% | 2.25% | -3.29% |
| Contribution of Labor Input Growth | -0.83% | 1.06% | 1.36% | 0.82% | -1.39% | -1.10% | -1.01% | -1.86% |
| Contribution of Man-hours Growth | -1.75% | 0.54% | 0.72% | 0.47% | -1.90% | -1.60% | -1.77% | -2.03% |
| Contribution of Labor Quality Growth | 0.92% | 0.53% | 0.64% | 0.36% | 0.51% | 0.50% | 0.76% | 0.16% |
| Contribution of Capital Input Growth | 1.13% | 0.39% | 1.61% | 1.83% | 1.28% | 0.52% | 0.28% | 0.76% |
| Contribution of Capital Quantity Growth | 1.71% | 0.44% | 1.12% | 1.41% | 1.21% | 0.37% | 0.04% | 0.58% |
| Contribution of Capital Quality Growth | -0.58% | -0.06% | 0.49% | 0.42% | 0.08% | 0.15% | 0.24% | 0.18% |
| TFP Growth | 2.40% | 6.08% | 4.11% | 2.46% | 0.60% | 1.50% | 2.98% | -2.19% |

Non-manufacturing sectors (JIP) excluding housing and activities not elsewhere classified)

| | 1970-75 | 1975-80 | 1980-85 | 1985-90 | 1990-95 | 1995-2000 | 2000-05 | 2005-09 |
|---|---|---|---|---|---|---|---|---|
| Real GDP Growth | 4.62% | 4.25% | 2.87% | 4.60% | 1.14% | 0.90% | 1.45% | -1.06% |
| Contribution of Labor Input Growth | 1.32% | 1.81% | 1.17% | 0.87% | 0.52% | -0.02% | 0.35% | -0.22% |
| Contribution of Man-hours Growth | 0.15% | 1.15% | 0.19% | 0.55% | 0.10% | -0.62% | -0.34% | -0.50% |
| Contribution of Labor Quality Growth | 1.17% | 0.66% | 0.98% | 0.32% | 0.42% | 0.59% | 0.68% | 0.28% |
| Contribution of Capital Input Growth | 1.51% | 1.42% | 1.91% | 1.91% | 1.31% | 0.80% | 0.44% | 0.01% |
| Contribution of Capital Quantity Growth | 2.04% | 1.56% | 1.63% | 1.48% | 1.32% | 0.68% | 0.25% | -0.02% |
| Contribution of Capital Quality Growth | -0.53% | -0.14% | 0.28% | 0.43% | -0.01% | 0.12% | 0.19% | 0.03% |
| TFP Growth | 1.78% | 1.02% | -0.21% | 1.82% | -0.70% | 0.12% | 0.66% | -0.85% |

IT Sectors (Compiled using JIP methodology)

| | 1970-75 | 1975-80 | 1980-85 | 1985-90 | 1990-95 | 1995-2000 | 2000-05 | 2005-09 |
|---|---|---|---|---|---|---|---|---|
| Real GDP Growth | 7.00% | 8.70% | 6.07% | 8.60% | 3.80% | 2.46% | 3.16% | -1.52% |
| Contribution of Labor Input Growth | 1.41% | 2.41% | 2.04% | 0.99% | 0.01% | -0.37% | -0.05% | 0.11% |
| Contribution of Man-hours Growth | 0.36% | 1.79% | 1.18% | 0.65% | -0.42% | -0.81% | -0.70% | -0.11% |
| Contribution of Labor Quality Growth | 1.05% | 0.62% | 0.86% | 0.34% | 0.43% | 0.44% | 0.65% | 0.21% |
| Contribution of Capital Input Growth | 1.70% | 1.14% | 1.78% | 2.12% | 1.43% | 1.11% | 0.91% | 0.29% |
| Contribution of Capital Quantity Growth | 1.85% | 0.86% | 1.05% | 1.44% | 1.19% | 0.82% | 0.52% | 0.25% |
| Contribution of Capital Quality Growth | -0.15% | 0.29% | 0.73% | 0.69% | 0.24% | 0.29% | 0.39% | 0.04% |
| TFP Growth | 3.89% | 5.15% | 2.25% | 5.49% | 2.35% | 1.71% | 2.31% | -1.91% |

Non-IT sectors (Compiled using JIP methodology)

| | 1970-75 | 1975-80 | 1980-85 | 1985-90 | 1990-95 | 1995-2000 | 2000-05 | 2005-09 |
|---|---|---|---|---|---|---|---|---|
| Real GDP Growth | 2.11% | 3.17% | 3.25% | 3.35% | -1.58% | -0.92% | -0.19% | -3.05% |
| Contribution of Labor Input Growth | -0.03% | 1.09% | 0.38% | 0.91% | -0.14% | -0.72% | -0.69% | -1.05% |
| Contribution of Man-hours Growth | -0.96% | 0.39% | -0.37% | 0.53% | -0.50% | -1.25% | -1.24% | -1.29% |
| Contribution of Labor Quality Growth | 0.94% | 0.70% | 0.75% | 0.38% | 0.36% | 0.53% | 0.56% | 0.24% |
| Contribution of Capital Input Growth | 1.59% | 1.10% | 1.86% | 1.79% | 1.28% | 0.35% | 0.10% | 0.25% |
| Contribution of Capital Quantity Growth | 2.23% | 1.49% | 1.75% | 1.65% | 1.32% | 0.44% | 0.06% | 0.06% |
| Contribution of Capital Quality Growth | -0.64% | -0.38% | 0.11% | 0.14% | -0.04% | -0.09% | 0.04% | 0.20% |
| TFP Growth | 0.54% | 0.97% | 1.02% | 0.65% | -2.72% | -0.55% | 0.39% | -2.25% |

Services (Own classification, JIP Methodology)

| | 1970-75 | 1975-80 | 1980-85 | 1985-90 | 1990-95 | 1995-2000 | 2000-05 | 2005-09 |
|---|---|---|---|---|---|---|---|---|
| Real GDP Growth | 5.23% | 5.74% | 4.17% | 5.54% | 2.13% | 1.03% | 1.76% | -1.96% |
| Contribution of Labor Input Growth | 1.54% | 2.05% | 1.43% | 0.97% | 0.37% | -0.18% | 0.06% | 0.21% |
| Contribution of Man-hours Growth | 0.82% | 1.73% | 0.85% | 0.90% | 0.11% | -0.44% | -0.49% | -0.11% |
| Contribution of Labor Quality Growth | 0.72% | 0.32% | 0.58% | 0.07% | 0.25% | 0.25% | 0.56% | 0.31% |
| Contribution of Capital Input Growth | 2.83% | 1.84% | 2.20% | 2.33% | 1.56% | 0.90% | 0.66% | 0.13% |
| Contribution of Capital Quantity Growth | 2.88% | 1.83% | 1.76% | 1.82% | 1.41% | 0.67% | 0.30% | 0.01% |
| Contribution of Capital Quality Growth | -0.06% | 0.01% | 0.43% | 0.51% | 0.16% | 0.23% | 0.36% | 0.12% |
| TFP Growth | 0.86% | 1.85% | 0.54% | 2.24% | 0.21% | 0.31% | 1.03% | -2.29% |

*Output and material input growth rates are calculated using a cost-based Divisia quantity index.*

## Appendix 3: Regression Tables

### Regulation, Subsidies and Productivity

**Table 1: Services sector_ without subsidies Fixed Effect**

| | A | | TFPDA | | TFPDB | | TFPDC | | TFPDD | |
|---|---|---|---|---|---|---|---|---|---|---|
| | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio |
| const | 0.221 | 0.325 | -0.051 | -0.246 | -0.021 | -0.100 | 0.131 | 0.533 | -0.098 | -0.492 |
| REG1 | -0.019 | -0.091 | **-0.065** | **-1.708** | -0.064 | -1.590 | **-0.097** | **-3.553** | -0.064 | -1.711 |
| REG2 | -0.074 | -1.516 | -0.002 | -0.102 | -0.001 | -0.028 | -0.019 | -0.897 | -0.004 | -0.208 |
| RDY | **6.002** | **5.481** | 0.665 | 1.500 | 0.712 | 1.534 | 0.723 | 1.392 | 0.573 | 1.348 |
| RDL | **-6.582** | **-5.238** | **-0.591** | **-2.071** | **-0.662** | **-2.137** | **-0.819** | **-2.784** | -0.463 | -1.634 |
| ITY | 0.016 | 1.752 | **-0.005** | **-2.081** | -0.004 | -1.700 | -0.001 | -0.418 | -0.004 | -1.588 |
| LK | 0.000 | -0.042 | **-0.002** | **-3.786** | **-0.002** | **-4.366** | **-0.002** | **-3.355** | **-0.002** | **-3.857** |
| SI | -0.013 | -0.293 | 0.007 | 0.489 | 0.005 | 0.359 | -0.004 | -0.231 | 0.010 | 0.754 |
| time | 0.008 | 0.957 | 0.000 | 0.094 | 0.000 | -0.123 | 0.004 | 1.130 | 0.000 | -0.099 |

**Table 2: Services sector_ without subsidies First Difference**

| | A | | TFPDA | | TFPDB | | TFPDC | | TFPDD | |
|---|---|---|---|---|---|---|---|---|---|---|
| | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio |
| const | -0.099 | -4.155 | 0.005 | 0.587 | 0.010 | 1.289 | 0.009 | 1.084 | 0.004 | 0.432 |
| d_REG1 | 0.041 | 0.245 | **-0.063** | **-2.818** | **-0.062** | **-2.755** | -0.047 | -1.744 | **-0.065** | **-3.536** |
| d_REG2 | -0.064 | -1.109 | -0.014 | -0.605 | -0.012 | -0.519 | -0.020 | -0.751 | -0.017 | -0.732 |
| d_RDY | -3.486 | -1.210 | -0.348 | -0.760 | -0.342 | -0.745 | -0.009 | -0.022 | -0.264 | -0.595 |
| d_RDL | **-3.273** | **-1.730** | 0.239 | 0.683 | 0.271 | 0.751 | 0.293 | 0.690 | 0.273 | 0.812 |
| d_ITY | **-0.130** | **-7.007** | **-0.025** | **-3.039** | **-0.022** | **-2.801** | **-0.064** | **-6.858** | **-0.021** | **-2.048** |
| d_LK | 0.001 | 0.809 | **0.003** | **3.006** | **0.003** | **2.954** | **0.003** | **3.003** | **0.003** | **2.976** |
| d_SI | **0.220** | **2.994** | -0.015 | -0.627 | -0.017 | -0.695 | -0.018 | -0.533 | -0.011 | -0.430 |
| time | **0.021** | **2.544** | 0.000 | 0.105 | -0.001 | -0.251 | 0.000 | 0.145 | 0.000 | 0.177 |

**Table 3: Manufacturing sector_ without subsidies First Difference**

| | A | | TFPDA | | TFPDB | | TFPDC | | TFPDD | |
|---|---|---|---|---|---|---|---|---|---|---|
| | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio |
| const | **-0.136** | **-2.269** | 0.012 | 1.752 | **0.014** | **2.049** | 0.011 | 1.708 | 0.011 | 1.687 |
| d_REG1 | -0.459 | -1.688 | -0.007 | -0.263 | -0.007 | -0.263 | 0.000 | 0.014 | 0.000 | -0.014 |
| d_REG2 | 0.284 | 1.021 | 0.028 | 0.859 | 0.028 | 0.843 | 0.024 | 0.722 | 0.025 | 0.750 |
| d_RDY | -0.003 | -0.151 | 0.008 | 1.555 | 0.007 | 1.500 | **0.006** | **1.218** | 0.006 | 1.223 |
| d_RDL | 0.035 | 1.389 | -0.008 | -1.881 | -0.007 | -1.725 | -0.007 | -1.490 | -0.007 | -1.478 |
| d_ITY | 0.084 | 0.856 | 0.000 | -0.024 | -0.002 | -0.109 | -0.001 | -0.045 | -0.001 | -0.043 |
| d_LK | **0.047** | **2.895** | 0.002 | 0.804 | 0.002 | 0.864 | 0.002 | 0.694 | 0.002 | 0.712 |
| d_SI | **0.606** | **2.179** | 0.011 | 0.656 | 0.012 | 0.706 | 0.010 | 0.615 | 0.011 | 0.665 |
| time | **0.023** | **2.883** | -0.003 | -1.739 | **-0.003** | **-1.859** | -0.003 | -1.574 | -0.003 | -1.572 |

**Table 4: IT sector_ without subsidies First Difference**

| | A | | TFPDA | | TFPDB | | TFPDC | | TFPDD | |
|---|---|---|---|---|---|---|---|---|---|---|
| | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio |
| const | **-0.047** | **-2.255** | **0.023** | **2.113** | **0.028** | **2.736** | **0.028** | **2.376** | 0.020 | 1.704 |
| d_REG1 | -0.083 | -0.750 | 0.016 | 0.388 | 0.019 | 0.456 | 0.026 | 0.423 | 0.019 | 0.489 |
| d_REG2 | -0.119 | -1.165 | **-0.091** | **-2.254** | **-0.089** | **-2.277** | **-0.090** | **-2.009** | **-0.093** | **-2.320** |
| d_RDY | 0.158 | 1.918 | 0.003 | 0.276 | 0.000 | 0.022 | 0.007 | 0.516 | 0.003 | 0.217 |
| d_RDL | **-0.125** | **-1.994** | -0.015 | -1.957 | -0.013 | -1.613 | -0.017 | -1.780 | -0.015 | -1.988 |
| d_ITY | **-0.088** | **-2.525** | -0.017 | -1.624 | -0.016 | -1.486 | **-0.053** | **-3.390** | -0.014 | -1.270 |
| d_LK | **0.006** | **2.351** | **0.006** | **3.213** | **0.006** | **3.270** | **0.006** | **2.933** | **0.006** | **3.160** |
| d_SI | 0.160 | 1.814 | -0.027 | -0.936 | -0.030 | -1.068 | -0.037 | -0.952 | -0.023 | -0.769 |
| time | 0.015 | 1.601 | 0.000 | -0.020 | -0.001 | -0.252 | **0.001** | **0.281** | 0.001 | 0.213 |

**Table 5: Non IT sector_ without subsidies First Difference**

| | A | | TFPDA | | TFPDB | | TFPDC | | TFPDD | |
|---|---|---|---|---|---|---|---|---|---|---|
| | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | |
| const | **-0.111** | **-3.680** | 0.006 | 0.984 | 0.010 | 1.470 | 0.007 | 1.071 | 0.007 | 1.057 |
| d_REG1 | **-0.205** | **-2.487** | **-0.100** | **-3.840** | **-0.101** | **-3.854** | -0.088 | -3.137 | **-0.087** | **-3.136** |
| d_REG2 | 0.099 | 1.308 | 0.031 | 1.610 | 0.030 | 1.561 | **0.030** | **1.478** | 0.032 | 1.636 |
| d_RDY | -0.026 | -1.262 | 0.012 | 1.716 | 0.012 | 1.657 | 0.010 | 1.342 | 0.010 | 1.398 |
| d_RDL | **0.035** | **1.962** | -0.008 | -1.503 | -0.008 | -1.432 | -0.006 | -1.100 | -0.006 | -1.135 |
| d_ITY | 0.114 | 0.557 | -0.040 | -0.829 | -0.045 | -0.860 | -0.033 | -0.673 | -0.037 | -0.775 |
| d_LK | 0.000 | 0.042 | **0.003** | **3.424** | **0.002** | **3.565** | **0.003** | **3.288** | **0.003** | **3.377** |
| d_SI | **0.508** | **2.797** | **0.028** | **1.909** | **0.027** | **1.846** | **0.030** | **2.069** | **0.028** | **2.021** |
| time | **0.017** | **3.782** | -0.003 | -1.362 | -0.004 | -1.572 | -0.003 | -1.425 | -0.003 | -1.372 |

**Table 6: Services sector_ subsidies Fixed Effect**

| | A | | TFPDA | | TFPDB | | TFPDC | | TFPDD | |
|---|---|---|---|---|---|---|---|---|---|---|
| | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio |
| const | 0.307 | 0.560 | -0.183 | -1.227 | -0.139 | -0.933 | -0.034 | -0.186 | -0.227 | -1.468 |
| REG1 | -0.009 | -0.039 | -0.047 | -1.218 | -0.046 | -1.116 | **-0.076** | **-3.068** | -0.046 | -1.253 |
| REG2 | -0.078 | -1.564 | -0.002 | -0.087 | -0.001 | -0.044 | -0.017 | -0.753 | -0.003 | -0.139 |
| RDY | **6.092** | **3.590** | **0.754** | **2.421** | **0.755** | **2.420** | 0.966 | 2.280 | **0.807** | **2.278** |
| RDL | **-6.053** | **-9.921** | **-0.529** | **-2.538** | **-0.557** | **-2.687** | **-0.847** | **-3.585** | **-0.508** | **-2.207** |
| ITY | -0.002 | -0.023 | 0.015 | 0.331 | 0.024 | 0.548 | 0.007 | 0.159 | -0.002 | -0.060 |
| LK | 0.000 | -0.262 | **-0.002** | **-3.831** | **-0.002** | **-4.478** | **-0.002** | **-3.514** | **-0.002** | **-3.842** |
| SI | -0.020 | -0.561 | 0.015 | 1.471 | 0.012 | 1.192 | 0.006 | 0.534 | 0.018 | 1.721 |
| SUB | **0.000** | **-3.292** | 0.000 | -0.903 | 0.000 | -1.424 | 0.000 | -0.186 | 0.000 | -0.403 |
| time | 0.010 | 1.208 | -0.001 | -0.477 | -0.002 | -0.752 | 0.002 | 0.655 | -0.001 | -0.457 |

**Table 7: Services sector_ subsidies First difference**

| | A | | TFPDA | | TFPDB | | TFPDC | | TFPDD | |
|---|---|---|---|---|---|---|---|---|---|---|
| | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio |
| const | **-0.077** | **-3.269** | 0.016 | 1.609 | **0.021** | **2.273** | 0.017 | 1.633 | 0.016 | 1.583 |
| d_REG1 | 0.060 | 0.353 | **-0.063** | **-3.060** | **-0.063** | **-3.037** | **-0.056** | **-2.606** | **-0.067** | **-4.093** |
| d_REG2 | -0.001 | -0.017 | 0.001 | 0.040 | 0.003 | 0.131 | 0.000 | -0.009 | -0.002 | -0.091 |
| d_RDY | -4.261 | -1.581 | -0.158 | -0.343 | -0.156 | -0.327 | 0.101 | 0.246 | -0.029 | -0.066 |
| d_RDL | -2.310 | -1.394 | **0.766** | **2.055** | **0.787** | **2.061** | **0.938** | **2.350** | **0.846** | **2.407** |
| d_ITY | -0.148 | -1.255 | -0.077 | -1.613 | -0.066 | -1.539 | **-0.094** | **-2.043** | **-0.096** | **-2.108** |
| d_LK | 0.002 | 1.203 | **0.004** | **3.598** | **0.004** | **3.613** | **0.004** | **3.512** | **0.004** | **3.507** |
| d_SI | **0.294** | **6.636** | -0.005 | -0.307 | -0.006 | -0.378 | 0.006 | 0.363 | -0.002 | -0.102 |
| d_SUB | 0.000 | 0.164 | **0.000** | **-1.913** | **0.000** | **-2.164** | 0.000 | -1.087 | 0.000 | -1.513 |
| time | **0.012** | **2.090** | -0.003 | -1.256 | -0.004 | -1.691 | -0.003 | -1.375 | -0.003 | -1.154 |

**Table 8: Manufacturing sector_ subsidies First Difference**

| | A | | TFPDA | | TFPDB | | TFPDC | | TFPDD | |
|---|---|---|---|---|---|---|---|---|---|---|
| | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio |
| const | **-0.153** | **-2.313** | 0.006 | 0.770 | 0.008 | 1.006 | 0.006 | 0.746 | 0.006 | 0.728 |
| d_REG1 | -0.907 | -1.470 | -0.013 | -0.239 | -0.018 | -0.314 | -0.007 | -0.129 | -0.009 | -0.159 |
| d_REG2 | 0.371 | 1.030 | **0.065** | **1.877** | **0.065** | **1.885** | 0.063 | 1.847 | **0.065** | **1.904** |
| d_RDY | 0.006 | 0.226 | **0.008** | **1.844** | 0.008 | 1.779 | 0.007 | 1.459 | 0.007 | 1.465 |
| d_RDL | 0.026 | 0.816 | **-0.006** | **-1.864** | -0.005 | -1.626 | -0.005 | -1.372 | -0.005 | -1.356 |
| d_ITY | 0.181 | 1.036 | -0.010 | -0.418 | -0.010 | -0.418 | -0.011 | -0.478 | -0.011 | -0.468 |
| d_LK | **0.039** | **2.220** | 0.001 | 0.268 | 0.001 | 0.332 | 0.001 | 0.207 | 0.001 | 0.224 |
| d_SI | **0.715** | **2.186** | 0.022 | 1.217 | 0.023 | 1.320 | 0.021 | 1.197 | 0.021 | 1.261 |
| d_SUB | **0.000** | **2.544** | 0.000 | 0.027 | 0.000 | 0.051 | 0.000 | -0.431 | 0.000 | -0.397 |
| time | **0.023** | **2.582** | -0.002 | -0.913 | -0.002 | -1.020 | -0.002 | -0.794 | -0.002 | -0.795 |

**Table 9: IT sector_ subsidies First Difference**

| | A | | TFPDA | | TFPDB | | TFPDC | | TFPDD | |
|---|---|---|---|---|---|---|---|---|---|---|
| | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | |
| const | -0.046 | -1.772 | 0.032 | 2.102 | 0.038 | 2.750 | 0.030 | 1.877 | 0.029 | 1.791 |
| d_REG1 | -0.208 | -0.943 | 0.121 | 1.550 | 0.116 | 1.592 | 0.130 | 1.495 | 0.128 | 1.511 |
| d_REG2 | -0.042 | -0.495 | **-0.086** | **-1.907** | **-0.084** | **-1.906** | **-0.084** | **-1.823** | **-0.087** | **-1.898** |
| d_RDY | **0.155** | **1.846** | 0.005 | 0.303 | 0.001 | 0.104 | 0.008 | 0.518 | 0.007 | 0.458 |
| d_RDL | -0.104 | -1.666 | 0.000 | -0.009 | 0.002 | 0.127 | 0.000 | -0.024 | -0.001 | -0.057 |
| d_ITY | 0.052 | 0.417 | -0.056 | -1.475 | -0.049 | -1.440 | -0.069 | -1.624 | -0.065 | -1.615 |
| d_LK | 0.006 | 2.272 | **0.007** | **3.688** | **0.007** | **3.725** | **0.006** | **3.567** | **0.007** | **3.576** |
| d_SI | **0.265** | **3.914** | -0.012 | -0.636 | -0.016 | -0.890 | -0.006 | -0.312 | -0.008 | -0.397 |
| d_SUB | 0.000 | -1.099 | 0.000 | -0.652 | 0.000 | -0.883 | 0.000 | 0.195 | 0.000 | -0.410 |
| time | 0.005 | 0.894 | -0.002 | -0.721 | -0.003 | -1.022 | -0.002 | -0.503 | -0.001 | -0.433 |

**Table 10: Non IT sector_ Subsidies First Difference**

| | A | | TFPDA | | TFPDB | | TFPDC | | TFPDD | |
|---|---|---|---|---|---|---|---|---|---|---|
| | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | t-ratio | coefficient | |
| const | **-0.118** | **-3.537** | 0.006 | 0.732 | 0.009 | 1.153 | 0.007 | 0.883 | 0.006 | 0.838 |
| d_REG1 | **-0.212** | **-2.574** | **-0.111** | **-4.032** | **-0.112** | **-4.061** | **-0.100** | **-3.374** | **-0.098** | **-3.314** |
| d_REG2 | 0.103 | 1.327 | 0.038 | 1.912 | 0.038 | 1.866 | 0.038 | 1.782 | 0.040 | 1.959 |
| d_RDY | -0.031 | -1.418 | 0.010 | 1.627 | 0.010 | 1.537 | 0.007 | 1.156 | 0.007 | 1.246 |
| d_RDL | 0.037 | 1.914 | -0.005 | -1.601 | -0.005 | -1.472 | -0.003 | -0.939 | -0.003 | -1.006 |
| d_ITY | 0.188 | 0.863 | -0.035 | -0.668 | -0.039 | -0.700 | -0.027 | -0.525 | -0.032 | -0.632 |
| d_LK | 0.001 | 0.296 | **0.003** | **3.059** | **0.003** | **3.184** | **0.003** | **2.961** | **0.003** | **2.990** |
| d_SI | **0.542** | **2.721** | 0.031 | 1.951 | 0.030 | 1.903 | **0.033** | **2.120** | **0.032** | **2.093** |
| d_SUB | 0.000 | -1.077 | 0.000 | -0.926 | 0.000 | -0.970 | 0.000 | -0.936 | 0.000 | -0.835 |
| time | **0.017** | **3.277** | -0.003 | -1.256 | -0.004 | -1.442 | -0.004 | -1.369 | -0.003 | -1.296 |

# Examining the IT/Non-IT divide

**Table 11: IT sector_ Intangible Assets**

| | A | | TFP | | | A | | TFP | |
|---|---|---|---|---|---|---|---|---|---|
| | coefficient | t-ratio | coefficient | t-ratio | | coefficient | t-ratio | coefficient | t-ratio |
| const | -1.254 | -1.053 | -0.394 | -1.472 | const | **-2.295** | **-2.877** | -0.332 | -1.549 |
| QL | 0.104 | 0.616 | 0.001 | 0.022 | d_QL | 0.079 | 0.537 | **-0.048** | **-1.181** |
| QK | -0.225 | -0.985 | 0.009 | 0.151 | d_QK | 0.249 | 0.402 | -0.029 | -0.224 |
| INTAY | -0.773 | -1.779 | -0.060 | -0.755 | d_INTAY | **-0.915** | **-2.400** | **-0.170** | **-1.985** |
| ECOC | 0.000 | -1.579 | **0.000** | **-2.484** | d_ECOC | 0.000 | -0.114 | 0.000 | 1.349 |
| INNY | **0.789** | **1.817** | 0.065 | 0.808 | d_INNY | **0.854** | **2.203** | **0.165** | **1.850** |
| LK | 0.000 | -0.009 | 0.003 | 0.908 | d_LK | 0.003 | 0.266 | **-0.006** | **-3.108** |
| SI | 0.109 | 1.323 | 0.029 | 1.543 | SI | **0.162** | **2.968** | 0.022 | 1.557 |
| time | **-0.018** | **-1.860** | -0.001 | -0.525 | time | **-0.022** | **-1.932** | **0.005** | **2.125** |

**Table 12: Non IT sector_ Intangible Assets**

| | A | | TFP | | | A | | TFP | |
|---|---|---|---|---|---|---|---|---|---|
| | coefficient | t-ratio | coefficient | t-ratio | | coefficient | t-ratio | coefficient | t-ratio |
| const | 0.052 | 0.059 | -0.051 | -0.446 | const | **-2.449** | **-2.669** | **-0.269** | **-2.073** |
| QL | 0.025 | 0.195 | 0.021 | 1.012 | d_QL | -0.264 | -1.110 | -0.043 | -1.090 |
| QK | -0.025 | -0.107 | 0.015 | 0.655 | d_QK | -0.070 | -0.381 | -0.050 | -1.683 |
| INTAY | **-1.952** | **-10.210** | -0.070 | -1.781 | d_INTAY | **-1.606** | **-5.850** | **-0.081** | **-2.004** |
| ECOC | 0.000 | -0.939 | **0.000** | **-2.449** | d_ECOC | 0.000 | -1.713 | 0.000 | -0.542 |
| INNY | **1.973** | **9.348** | 0.056 | 1.376 | d_INNY | **1.555** | **4.695** | 0.077 | 1.786 |
| LK | -0.006 | -1.088 | **-0.003** | **-2.458** | d_LK | -0.003 | -0.615 | -0.001 | -0.504 |
| SI | 0.009 | 0.173 | 0.002 | 0.333 | SI | **0.171** | **2.702** | 0.018 | 1.984 |
| time | -0.007 | -0.989 | 0.001 | 1.234 | time | -0.006 | -1.147 | **0.005** | **4.257** |

## Appendix 4: Decomposition by industry of Japanese growth accounting

Methodology: We use the following sheets in the JIP database (2012) in order to compile industry-level annual-frequency data as well as aggregates (compiled using the JIP methodology):

1. Input output table (5) – distribution of gross value added (current prices)
2. Capital Input - Investment by sector
4. Growth accounting

We then used Matlab to prepare this data for panel data analysis

We calibrated the industry-level data for labour and capital's share using similar methodology as Conesa, Kehoe and Ruhl (2007), with the following exceptions:

- Indusry-levels for capital (K) were given in the data, as such we did not recalibrate capital – rather, we used K to calibrate alpha and delta.
- Given the obvious absence of household mixed income and depreciation at industry level, we made an assumption that the nominal value added per industry excluded mixed income, only including value-added production.
- Given the obvious absence of population growth by industry, we also omitted the growth accounting measure of L/N, at the industrial level. The analysis however has been included in our previous work on the entire economy.
- We used sector-level deflators based on gross output as the closest approximation to the industry's share of the GDP deflator
- Given certain fluctuations in the data, neither alpha and delta were guaranteed to stay below 0 and 1 for all observations, so we placed an artificial constraint on delta and alpha.

We then calculated TFP and Solow residual using our calculated labour and capital share, Net Value added minus depreciation, and man-hours.

We then proceeded to index TFP growth at base year = 1973 and compared the developments in our calculated TFP to that available within JIP (we explain the differences above).

Industry and aggregation definitions overleaf.

| | Definition of aggregated sectors | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 500 |
|---|---|---|---|---|---|---|---|---|---|---|
| JIP Classification no. | Industry name | Macro economy (excluding housing and activities | Market economy | Manufacturing sectors | Non-manufacturing sectors (excluding housing and | Non-manufacturing sectors (only market | Macro economy | IT sectors | Non-IT sectors | Services |
| 1 | Rice, wheat production | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 2 | Miscellaneous crop farming | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 3 | Livestock and sericulture farming | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 4 | Agricultural services | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 5 | Forestry | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 6 | Fisheries | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 7 | Mining | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 8 | Livestock products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 9 | Seafood products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 10 | Flour and grain mill products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 11 | Miscellaneous foods and related products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 12 | Prepared animal foods and organic fertilizers | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 13 | Beverages | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 14 | Tobacco | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 15 | Textile products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 16 | Lumber and wood products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 17 | Furniture and fixtures | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 18 | Pulp, paper, and coated and glazed paper | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 19 | Paper products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 20 | Printing, plate making for printing | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 21 | Leather and leather products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 22 | Rubber products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 23 | Chemical fertilizers | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 24 | Basic inorganic chemicals | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 25 | Basic organic chemicals | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 26 | Organic chemicals | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 27 | Chemical fibers | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 28 | Miscellaneous chemical products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 29 | Pharmaceutical products | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 30 | Petroleum products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 31 | Coal products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 32 | Glass and its products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 33 | Cement and its products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 34 | Pottery | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 35 | Miscellaneous ceramic, stone | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 36 | Pig iron and crude steel | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 37 | Miscellaneous iron and steel | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 38 | Smelting and refining of non-ferrous metals | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 39 | Non-ferrous metal products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 40 | Fabricated constructional and architectural | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 41 | Miscellaneous fabricated metal products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 42 | General industry machinery | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 43 | Special industry machinery | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 44 | Miscellaneous machinery | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 45 | Office and service industry machines | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 46 | Electrical generating, transmission | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 47 | Household electric appliances | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 48 | Electronic data processing machines | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 49 | Communication equipment | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 50 | Electronic equipment | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 51 | Semiconductor devices and integrated circuits | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 52 | Electronic parts | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 53 | Miscellaneous electrical machinery equipment | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 54 | Motor vehicles | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 55 | Motor vehicle parts and accessories | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |

| | Definition of aggregated sectors | 201 | 202 | 203 | 204 | 205 | 206 | 207 | 208 | 500 |
|---|---|---|---|---|---|---|---|---|---|---|
| JIP Classification no. | Industry name | Macro economy (excluding housing and activities | Market economy | Manufacturing sectors | Non-manufacturing sectors (excluding housing and | Non-manufacturing sectors (only market | Macro economy | IT sectors | Non-IT sectors | Services |
| 56 | Other transportation equipment | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 57 | Precision machinery & equipment | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 58 | Plastic products | 1 | 1 | 1 | 0 | 0 | 1 | 0 | 1 | 0 |
| 59 | Miscellaneous manufacturing industries | 1 | 1 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| 60 | Construction | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 61 | Civil engineering | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 62 | Electricity | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 63 | Gas, heat supply | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 64 | Waterworks | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 65 | Water supply for industrial use | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 66 | Waste disposal | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 67 | Wholesale | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 68 | Retail | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 69 | Finance | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 70 | Insurance | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 71 | Real estate | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 72 | Housing | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| 73 | Railway | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 74 | Road transportation | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 75 | Water transportation | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 76 | Air transportation | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 77 | Other transportation and packing | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 78 | Telegraph and telephone | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 79 | Mail | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 80 | Education (private and non-profit) | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 81 | Research (private) | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 82 | Medical (private) | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 83 | Hygiene (private and non-profit) | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 84 | Other public services | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 85 | Advertising | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 86 | Rental of office equipment and goods | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 87 | Automobile maintenance services | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 88 | Other services for businesses | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 89 | Entertainment | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 90 | Broadcasting | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 91 | Information services | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 92 | Publishing | 1 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 1 |
| 93 | Video picture, sound information | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 0 |
| 94 | Eating and drinking places | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 95 | Accommodation | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 96 | Laundry, beauty and bath services | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 97 | Other services for individuals | 1 | 1 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| 98 | Education (public) | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 99 | Research (public) | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 100 | Medical (public) | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 101 | Hygiene (public) | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 102 | Social insurance and social | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 103 | Public administration | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 104 | Medical (non-profit) | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 105 | Social insurance and social welfare | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 106 | Research (non-profit) | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 107 | Other (non-profit) | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 |
| 108 | Activities not elsewhere classified | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

*Capital's share (alpha) and labour's share (1-alpha) by industry*

| | | |
|---|---|---|
| Electronic equipment and electric measuring instruments | 0.306636857 | 0.693363143 |
| Semiconductor devices and integrated circuits | 0.394997191 | 0.605002809 |
| Electronic parts | 0.338924254 | 0.661075746 |
| Miscellaneous electrical machinery equipment | 0.326619632 | 0.673380368 |
| Motor vehicles | 0.507014714 | 0.492985286 |
| Motor vehicle parts and accessories | 0.387751552 | 0.612248448 |
| Other transportation equipment | 0.066256962 | 0.933743038 |
| Precision machinery & equipment | 0.228297625 | 0.771702375 |
| Plastic products | 0.285054252 | 0.714945748 |
| Miscellaneous manufacturing industries | 0.186299153 | 0.813700847 |
| Construction | 0.185288154 | 0.814711846 |
| Civil engineering | 0.198986253 | 0.801013747 |
| Electricity | 0.771482276 | 0.228517724 |
| Gas, heat supply | 0.65194328 | 0.34805672 |
| Waterworks | 0.64833897 | 0.35166103 |
| Water supply for industrial use | 0.716157093 | 0.283842907 |
| Waste disposal | 0.216738094 | 0.783261906 |
| Wholesale | 0.329610126 | 0.670389874 |
| Retail | 0.128633668 | 0.871366332 |
| Finance | 0.547326063 | 0.452673937 |
| Insurance | 0.37773357 | 0.62226643 |
| Real estate | 0.659401279 | 0.340598721 |
| Railway | 0.425439234 | 0.574560766 |
| Road transportation | 0.003388179 | 0.996611821 |
| Water transportation | 0.188095606 | 0.811904394 |
| Air transportation | 0.447909583 | 0.552090417 |
| Other transportation and packing | 0.209603766 | 0.790396234 |
| Telegraph and telephone | 0.694041431 | 0.305958569 |
| Mail | 0.26663357 | 0.73336643 |
| Education (private and non-profit) | 0.118577781 | 0.881422219 |
| Research (private) | 0.073408071 | 0.926591929 |
| Medical (private) | 0.360746366 | 0.639253634 |
| Hygiene (private and non-profit) | 0.161616417 | 0.838383583 |
| Other public services | 0.239260867 | 0.760739133 |
| Advertising | 0.308158176 | 0.691841824 |
| Rental of office equipment and goods | 0.720917246 | 0.279082754 |
| Automobile maintenance services | 0.202655413 | 0.797344587 |
| Other services for businesses | 0.097953539 | 0.902046461 |
| Entertainment | 0.554825711 | 0.445174289 |
| Broadcasting | 0.511348754 | 0.488651246 |
| Information services and internet-based services | 0.253184038 | 0.746815962 |
| Publishing | 0.171423629 | 0.828576371 |
| Video picture, sound information, character information production and distribution | 0.158210455 | 0.841789545 |
| Eating and drinking places | 0.214787246 | 0.785212754 |
| Accommodation | 0.323902658 | 0.676097342 |
| Laundry, beauty and bath services | 0.196315388 | 0.803684612 |
| Other services for individuals | 0.196484421 | 0.803515579 |
| Education (public) | 0.148374817 | 0.851625183 |
| Research (public) | 0.042596333 | 0.957403667 |
| Medical (public) | 0.192580747 | 0.807419253 |
| Hygiene (public) | 0.022870378 | 0.977129622 |
| Social insurance and social welfare (public) | 0.041011185 | 0.958988815 |
| Public administration | 0.310561084 | 0.689438916 |
| Medical (non-profit) | 0.300343386 | 0.699656614 |
| Social insurance and social welfare (non-profit) | 0.06509977 | 0.93490023 |
| Research (non-profit) | 0.038892643 | 0.961107357 |
| Other (non-profit) | 0.04184498 | 0.95815502 |

| Production sector | Alpha | 1-Alpha |
|---|---|---|
| Rice, wheat production | 0.697257981 | 0.302742019 |
| Miscellaneous crop farming | 0.47858163 | 0.52141837 |
| Livestock and sericulture farming | 0.576235734 | 0.423764266 |
| Agricultural services | 0.118579811 | 0.881420189 |
| Forestry | 0.570682432 | 0.429317568 |
| Fisheries | 0.319174371 | 0.680825629 |
| Mining | 0.411126582 | 0.588873418 |
| Livestock products | 0.273020387 | 0.726979613 |
| Seafood products | 0.40985241 | 0.59014759 |
| Flour and grain mill products | 0.525889795 | 0.474110205 |
| Miscellaneous foods and related products | 0.26663936 | 0.73336064 |
| Prepared animal foods and organic fertilizers | 0.507102649 | 0.492897351 |
| Beverages | 0.49074407 | 0.50925593 |
| Tobacco | 0.540961673 | 0.459038327 |
| Textile products | 0.075264117 | 0.924735883 |
| Lumber and wood products | 0.14651516 | 0.85348484 |
| Furniture and fixtures | 0.140447958 | 0.859552042 |
| Pulp, paper, and coated and glazed paper | 0.521668863 | 0.478331137 |
| Paper products | 0.318067531 | 0.681932469 |
| Printing, plate making for printing and bookbinding | 0.214897632 | 0.785102368 |
| Leather and leather products | 0.091710763 | 0.908289237 |
| Rubber products | 0.264946996 | 0.735053004 |
| Chemical fertilizers | 0.568399458 | 0.431600542 |
| Basic inorganic chemicals | 0.594793732 | 0.405206268 |
| Basic organic chemicals | 0.668358452 | 0.331641548 |
| Organic chemicals | 0.579505277 | 0.420494723 |
| Chemical fibers | 0.471823983 | 0.528176017 |
| Miscellaneous chemical products | 0.550817913 | 0.449182087 |
| Pharmaceutical products | 0.637651614 | 0.362348386 |
| Petroleum products | 0.851159415 | 0.148840585 |
| Coal products | 0.672782493 | 0.327217507 |
| Glass and its products | 0.442244326 | 0.557755674 |
| Cement and its products | 0.345159372 | 0.654840628 |
| Pottery | 0.184942228 | 0.815057772 |
| Miscellaneous ceramic, stone and clay products | 0.333585692 | 0.666414308 |
| Pig iron and crude steel | 0.551851048 | 0.448148952 |
| Miscellaneous iron and steel | 0.57257542 | 0.42742458 |
| Smelting and refining of non-ferrous metals | 0.456370006 | 0.543629994 |
| Non-ferrous metal products | 0.447300672 | 0.552699328 |
| Fabricated constructional and architectural metal products | 0.169439022 | 0.830560978 |
| Miscellaneous fabricated metal products | 0.118158917 | 0.881841083 |
| General industry machinery | 0.23062507 | 0.76937493 |
| Special industry machinery | 0.271630302 | 0.728369698 |
| Miscellaneous machinery | 0.162369897 | 0.837630103 |
| Office and service industry machines | 0.337660852 | 0.662339148 |
| Electrical generating, transmission, distribution and industrial apparatus | 0.203737095 | 0.796262905 |
| Household electric appliances | 0.316714067 | 0.683285933 |
| Electronic data processing machines, digital and analog computer equipment and accessories | 0.359916676 | 0.640083324 |
| Communication equipment | 0.268251303 | 0.731748697 |